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(54) Improvements in or relating to continuously-variable-ratio transmission units

(57) An infinitely-variable ratio transmission unit comprising a toroidal race rolling traction unit 6 coupled to an epicyclic gear train 11 has gears 14,15 which perform the additional function of exercising a gear-pumping action to drive lubricant to another region of the unit. That region may be the ratio-varying unit 6 and the pumped lubricant may be delivered down a conduit 47 formed within the input shaft 4. The gear train is mounted within a casing member which acts so as to help direct lubricant, pumped by the intermesh action of the gears 14,15, into the conduit.

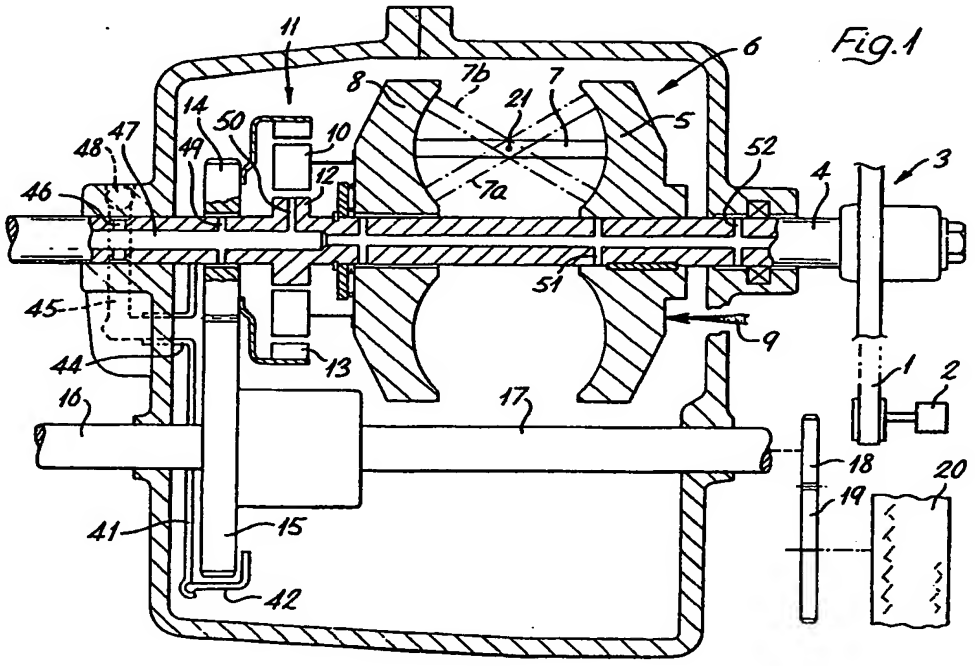

Fig.1

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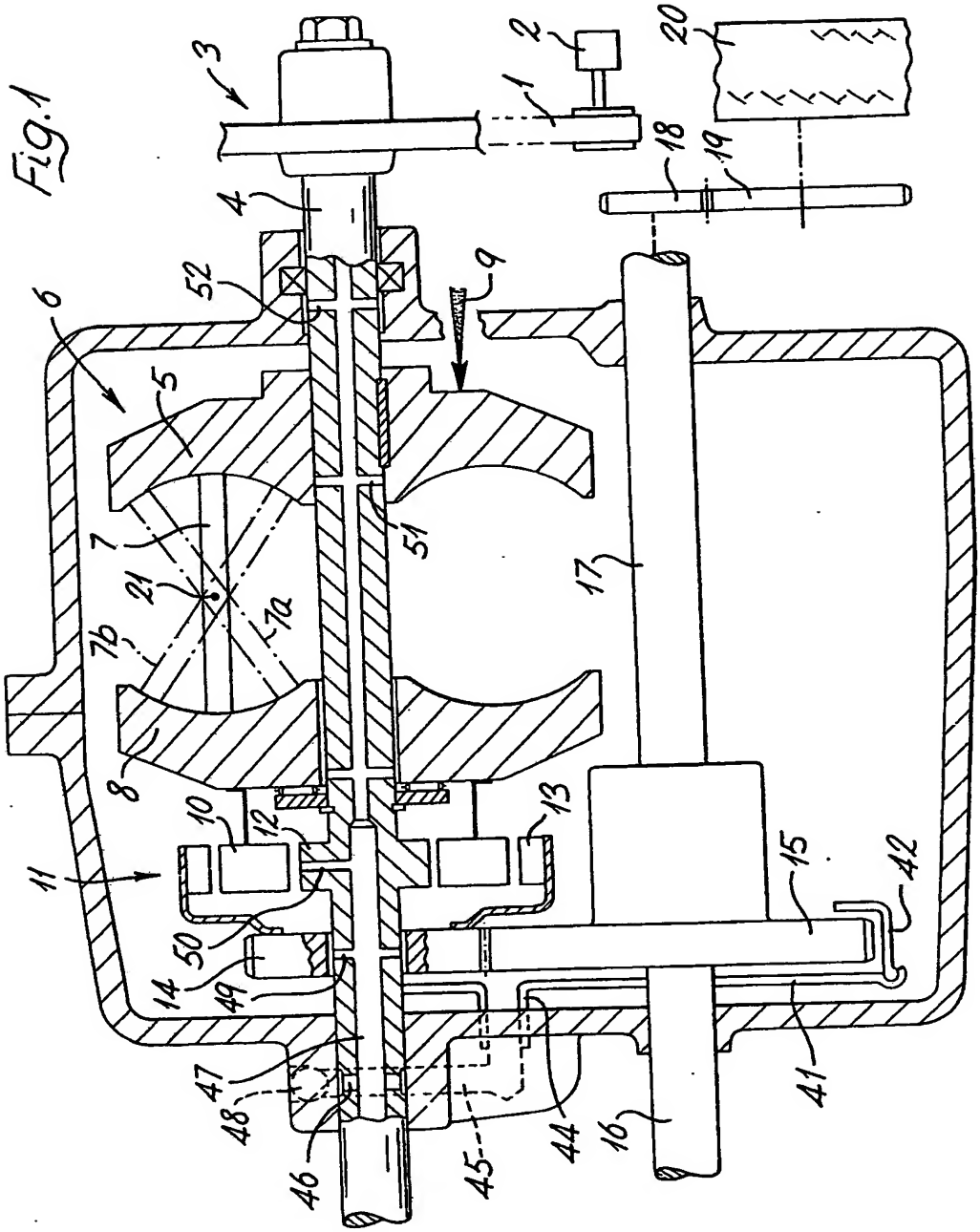
Fig.1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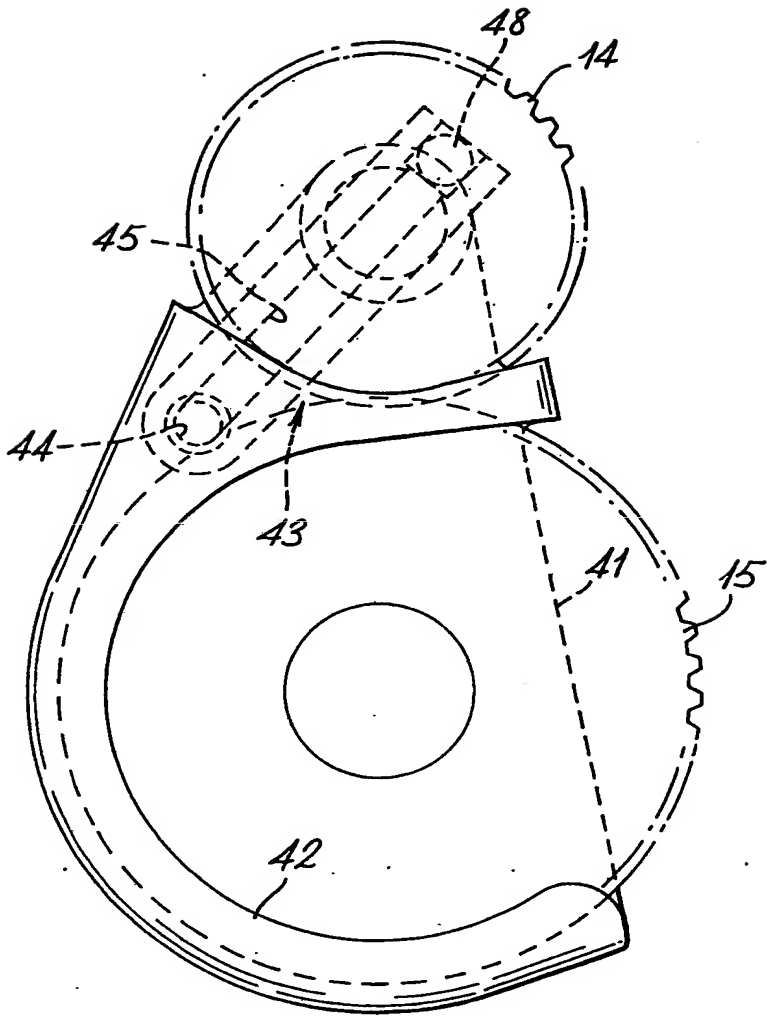

Fig. 2

SPECIFICATION

Improvements in or relating to continuously-variable-ratio transmission units

This invention relates to continuously-variable-ratio transmission units. It relates in particular to automotive transmissions, and to units in which the ratio-varying component—or "variator"—is of the toroidal race rolling traction type.

Such units typically comprise a variator, an epicyclic gear set, and reduction gearing arranged in succession. The output member of the reduction gearing constitutes the final drive of the transmission unit as a whole and in an automotive application is typically connected to the driven wheels of the vehicle, often by way of a differential. The purpose of the epicyclic gear set, different members of which will be connected respectively one to the output and another to the input of the variator, is to enable torque recirculation to take place within the unit. With this facility, and the appropriate choice of ratios within the epicyclic set, it becomes possible by a single continuous adjustment of the variator, from one extreme ratio to the other, to cause the final drive of the unit to change continuously from one extreme condition (e.g. full reverse) to the other (e.g. full forward) passing through a neutral condition in between.

According to the present invention, one of the essential components of such a transmission unit is arranged to fulfill the further and necessary task of ensuring a continuous and sufficient supply of lubricant to other parts of the unit. According to the invention an infintely variable ratio transmission unit comprises a variator and a gear train which in use rotates in contact with lubricant. A conduit for the passage of lubricant is provided between the region of the gear train and at least one other region of the unit requiring lubrication, and the train is adapted to exercise a gear-pumping action so as to drive lubricant down that conduit. The unit may include an input shaft for the variator, and the conduit may include a bore formed within that shaft.

The regions of the unit to be lubricated may include the variator, which may be of the toroidal race rolling traction type.

The gear train may be mounted within a casing member whereby lubricant pumped by the intermesh of a pair of the gears is directed into the conduit.

The gear train may be located either before the variator or after it in the transmission path. Typically it may be after the variator and take the form of reduction gearing. The epicyclic gearing, different components of which may be connected respectively to the input and to the output of the variator, may be located between the variator and the reduction gearing and act with recirculation effect whereby a single continuous adjustment of the variator from one end of its ratio range to the other results in the output of the transmission unit passing continuously from a first to a second of two extreme conditions, one of those conditions being maximum forward transmitted speed and the other maximum reverse.

The epicyclic gearing may be arranged so that the sun is connected to the variator input, the planets are arranged in pairs mounted on a carrier connected to the variator output, and the annulus is connected to the input member of the gear train.

The invention will now be described by way of example, with reference to the accompanying drawings in which:—

Figure 1 is a partly schematic section through a transmission unit, taken in the common plane of the axes of the variator and of the final drive, and

Figure 2 is a partial elevation of components associated with the pumping action, taken in the direction of the arrow II in Fig. 1.

A belt 1 transmits drive from a prime mover 2 to a pulley 3 mounted on the end of an input shaft 4 on which is mounted the input disc 5 of a variator 6 of the toroidal race rolling traction type. Three rollers 7, of which one is shown, transmit drive from disc 5 to the single output disc 8, the discs 5 and 8 being urged axially towards each other by appropriate end load mechanisms which are indicated schematically at 9 but which could be of several kinds all well known in the art. Disc 8 is connected to the carrier 10 of the planets of an epicyclic combination indicated in general at 11. The sun 12 of the combination is carried on shaft 4 and the annulus 13 is connected to the input gear 14 of a gear train in the form of torque-reducing pair, the output gear 15 of which is connected to output shafts 16 and 17. Each of those shafts is connected, by reduction gearing indicated in outline at 18 and 19, to one of the driven road wheels 20 of a vehicle.

By the use of known means (not shown) to turn the mountings of rollers 7 about axes 21 which lie perpendicular to the plane of the section, and by appropriate choice of the components and ratios of epicyclic combination 11, it may be arranged that a continuous turn of the mounting of the rollers 7, from one extreme of their angular range to the other, results in a corresponding and continuous change in the motion of output gear 15 from one extreme condition (e.g. maximum reverse speed) to the other (e.g. maximum forward speed), passing through a neutral condition in between. The extreme angular setting of the roller 7 indicated at 7a in Fig. 1 corresponds with maximum reverse speed of output 15, setting 7b with maximum forward, and setting 7c with the "neutral" condition in between in which the resultant of the contrary

motions of the carrier 10 and of the sun 12 is zero motion of annulus 13 and thus of output gear 15.

Gears 14 and 15 rotate within interfitting casing members 41 and 42, so shaped as to allow a gear pumping action to be exerted upon lubricating oil approaching the intermesh of the gears at 43. The pumped oil passes by way of a spout 44 (formed on member 41) into a conduit 45 the free end of which is blocked by a ball seal 48. From conduit 45 the pumped oil passes by way of radial drillings 46 into a central bore 47 formed within shaft 4. From this bore the pumped oil passes in turn, by way of further radial drillings, into contact with various of the elements of the transmission which require lubrication. Thus drillings 49–52 lead respectively towards the bearing of gear 14 upon shaft 4, the sun 12, the variator components, and an end main bearing of shaft 4.

CLAIMS

1. An infinitely-variable ratio transmission unit comprising a variator—that is to say, a ratio-varying component—and a gear train which in use rotates in contact with lubricant, in which a conduit for the passage of lubricant is provided between the region of the gear train and at least one other region of the unit requiring lubrication, and in which the gear train is adapted to exercise a gear-pumping action so as to drive lubricant down that conduit.

2. A transmission unit according to Claim 1 including an input shaft for the variator, and in which the conduit includes a bore formed within that shaft.

3. A transmission unit according to Claim 2 in which the regions of the unit to be lubricated include the variator.

4. A transmission unit according to Claim 1 in which the variator is of the toroidal race rolling traction type.

5. A transmission unit according to Claim 1 in which the gear train is located after the variator in the transmission path and in which epicyclic gearing, different components of which are connected respectively to the input and to the output of the variator, is located between the variator and the gear train and acts with recirculation effect whereby a single continuous adjustment of the variator from one end of its ratio range to the other results in the output of the transmission unit passing continuously from a first to a second of two extreme conditions, one of those conditions being maximum forward transmitted speed and the other maximum reverse.

6. A transmission unit according to Claim 1 in which the gear train is mounted within a casing member whereby lubricant pumped by the intermesh of a pair of the gears is directed into the conduit.

7. A transmission unit according to Claim 5 in which the sun of the epicyclic gearing is connected to the variator input, the planets are arranged in pairs mounted on a carrier connected to the variator output, and the annulus is connected to the input member of the gear train.

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